

MODIS Ocean Quality Assurance: Progress and Lessons Learned

MODIS Ocean Data Assessment Team (MODAT)

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EOS Quality Assurance Working Group

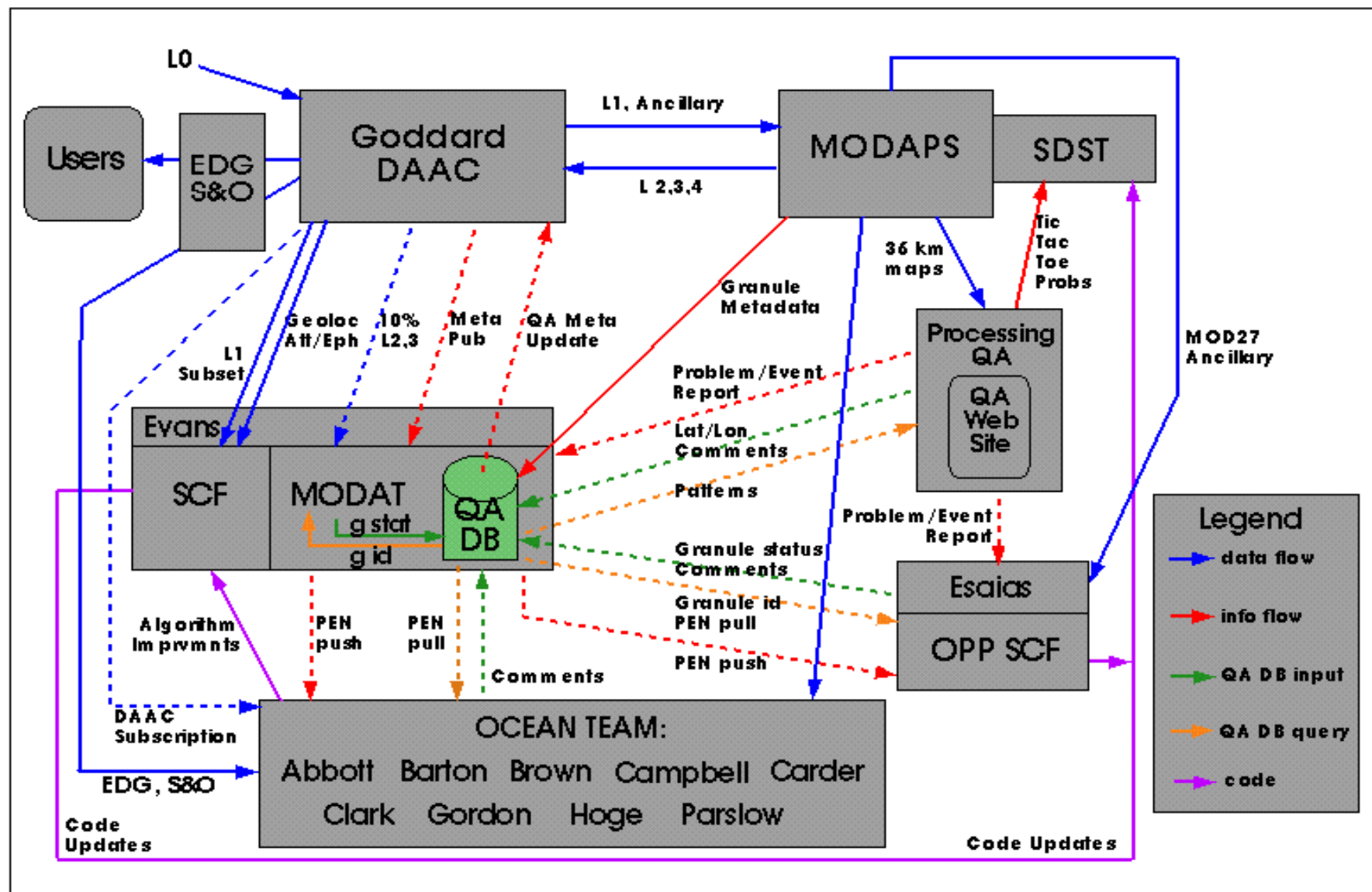
Boulder, CO

March 27-28, 2001

Outline

1. QA Plan
2. QA Process
 - a. Run-time QA (pixel-level)
 - b. Processing QA
 - Tools for Processing QA
 - c. Science QA
 - Tools, QA DB, Known Problems
3. Lessons Learned
4. Future Directions

MODIS Ocean Data Quality Assurance



Run-time QA

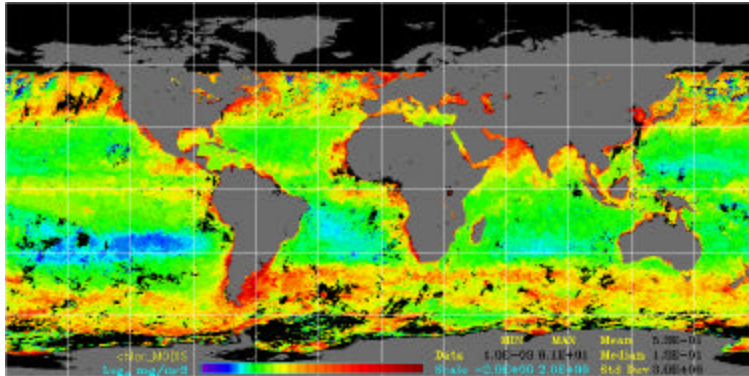
- QA values are set at the pixel level by the processing code, based on inputs and threshold values.
- Quality Levels (for every pixel)
 - 0 = good, 1 = questionable, 2 = cloud, 3 = bad
- Different users have varying needs. Some users desire highest quality data for computation. Others trade quality for better coverage.

Run-time QA (cont')

- Data products contain data at all quality levels. Users filter data by quality level to obtain desired quality.
- When binning pixels into reduced spatial or temporal resolution bins, only the highest quality pixels are binned. Different quality levels are never mixed within a bin.
- At Level 3, interim data is compared to a sliding 3-week average. Bins that deviate from the average (by more than a threshold) are demoted in quality. This improves the accuracy of the upper quality levels by eliminating transient clouds and aerosol contaminated bins.

MODIS chlorophyll Weekly, Dec 10 – 17, 2000

Bins at ALL quality levels are depicted



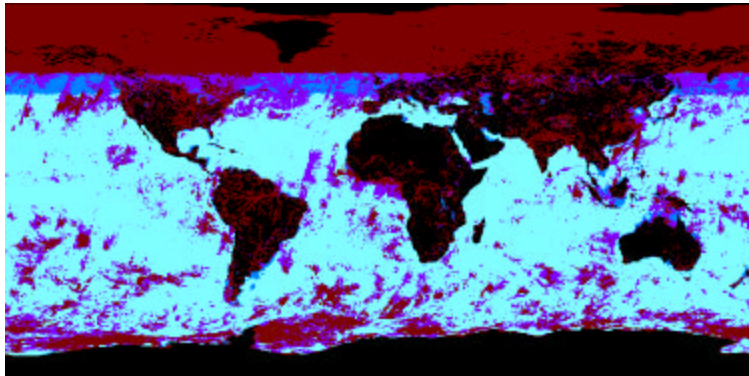
Map of quality levels:

Light blue = good

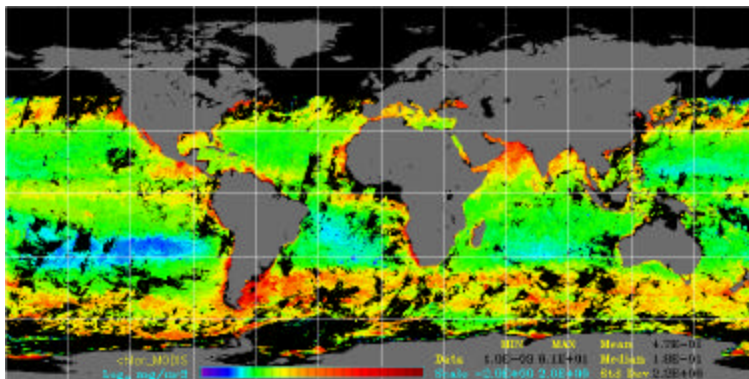
Dark blue = questionable

Purple = cloud

Red = bad other than cloud



Bins at only GOOD quality level
are depicted



Processing QA

- Data processing is verified to see if all files were produced successfully.
 - **Tool:** Tic Tac Toe charts
- All products are briefly viewed at coarse resolution to determine missing data and gross scientific problems. A ‘triage’ approach.
 - **Tool:** QA web browse
- When processing errors are uncovered: production logs are investigated, coding teams are notified for further investigation and code fixes. If possible, data is corrected in a timely fashion.

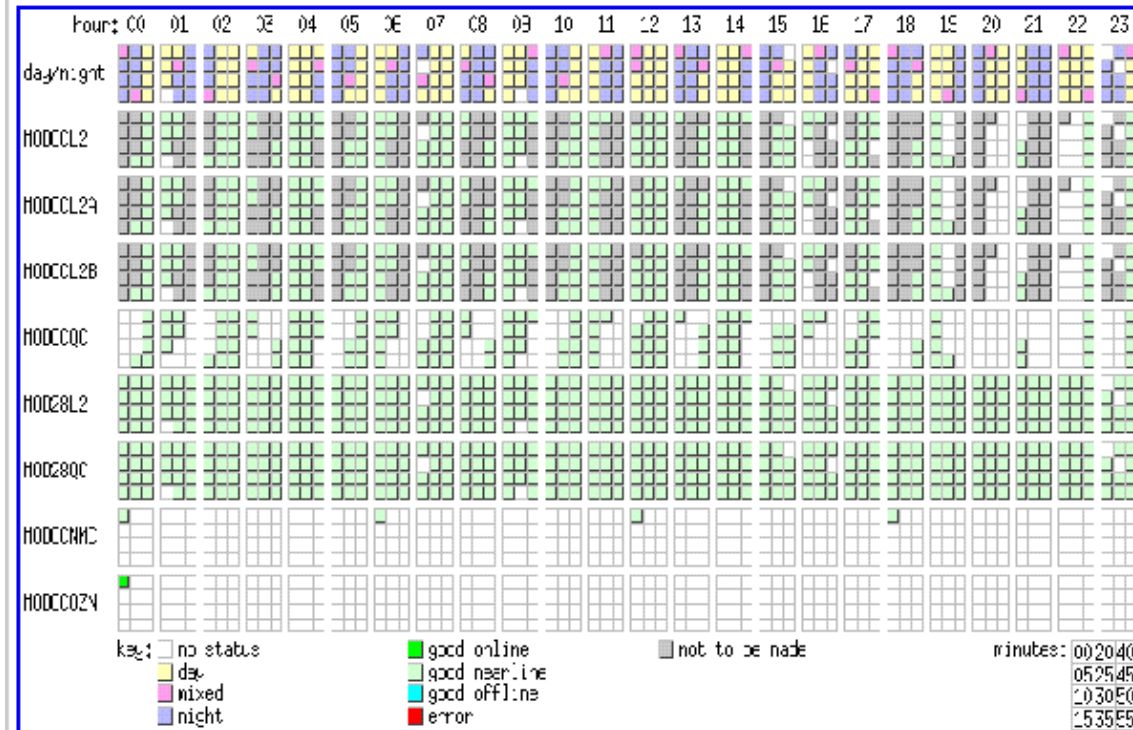
Processing QA (cont')

- Verifies that processing code changes produce the desired results.
- Observes effect of sensor changes on MODIS Ocean products.
- Problem geographic regions are identified for further investigation by Science QA.
 - **Tool:** Java tool for identifying regions.

Granule Image for 1999 049

Fri Nov 12 10:58:01 1999

begin - end



[\[Back To Main Page \]](#)

For further information contact: metshelp@itpmail.gsfc.nasa.gov

Responsible NASA Official: [Ed Masuoka](#)

Web Curator: problem@itpmail.gsfc.nasa.gov

Return to the [MODIS Emergency Backup Data Ordering System Home Page](#).

Level 2 Tic-Tac-Toe

Each box represents one granule on this day for all Ocean Level 2 products.

Missing and failed granules are indicated.

- 144 granules/day for daytime products

- 288 granules/day for nighttime products

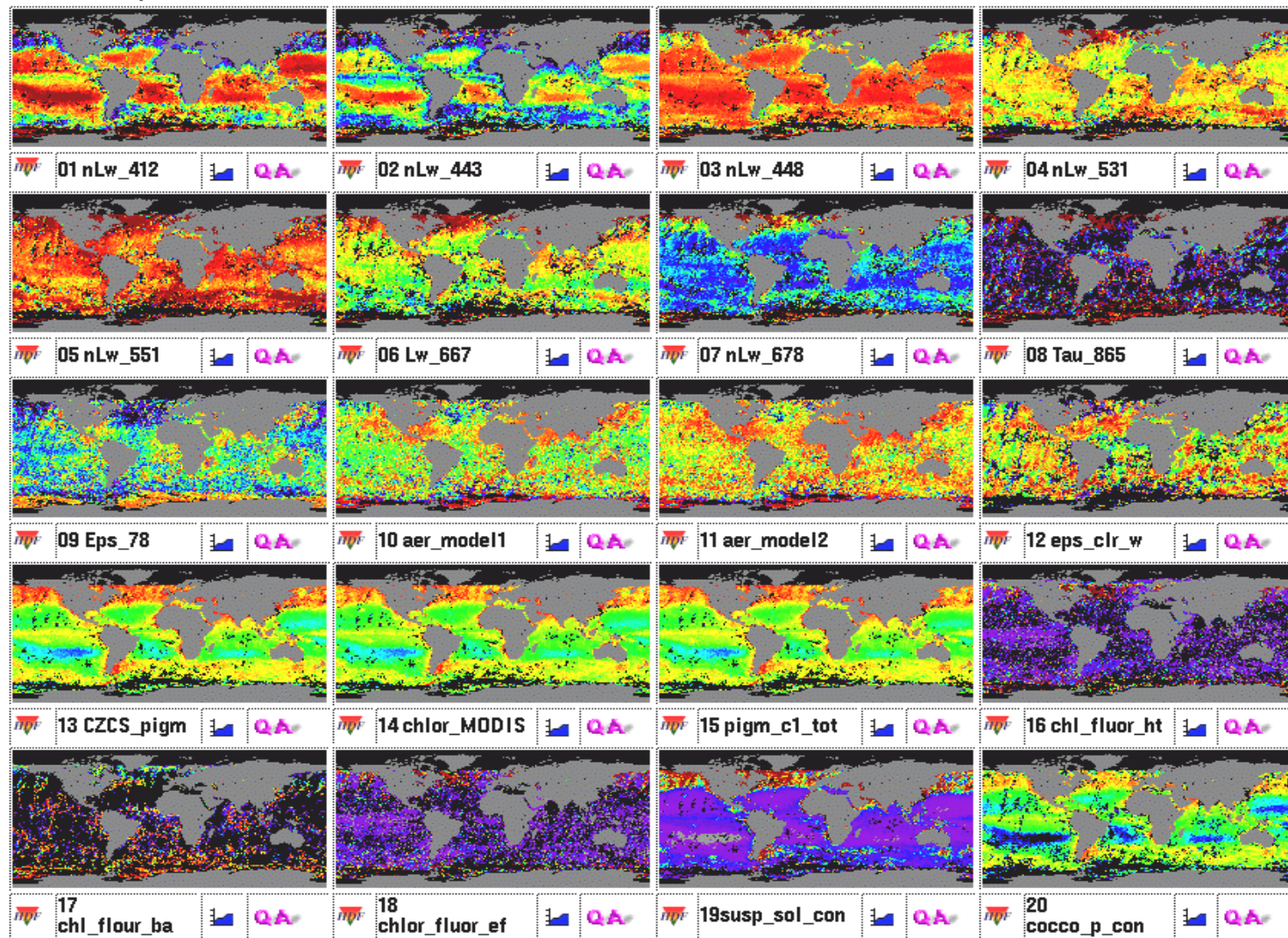
Missing files
indicate processing
errors.

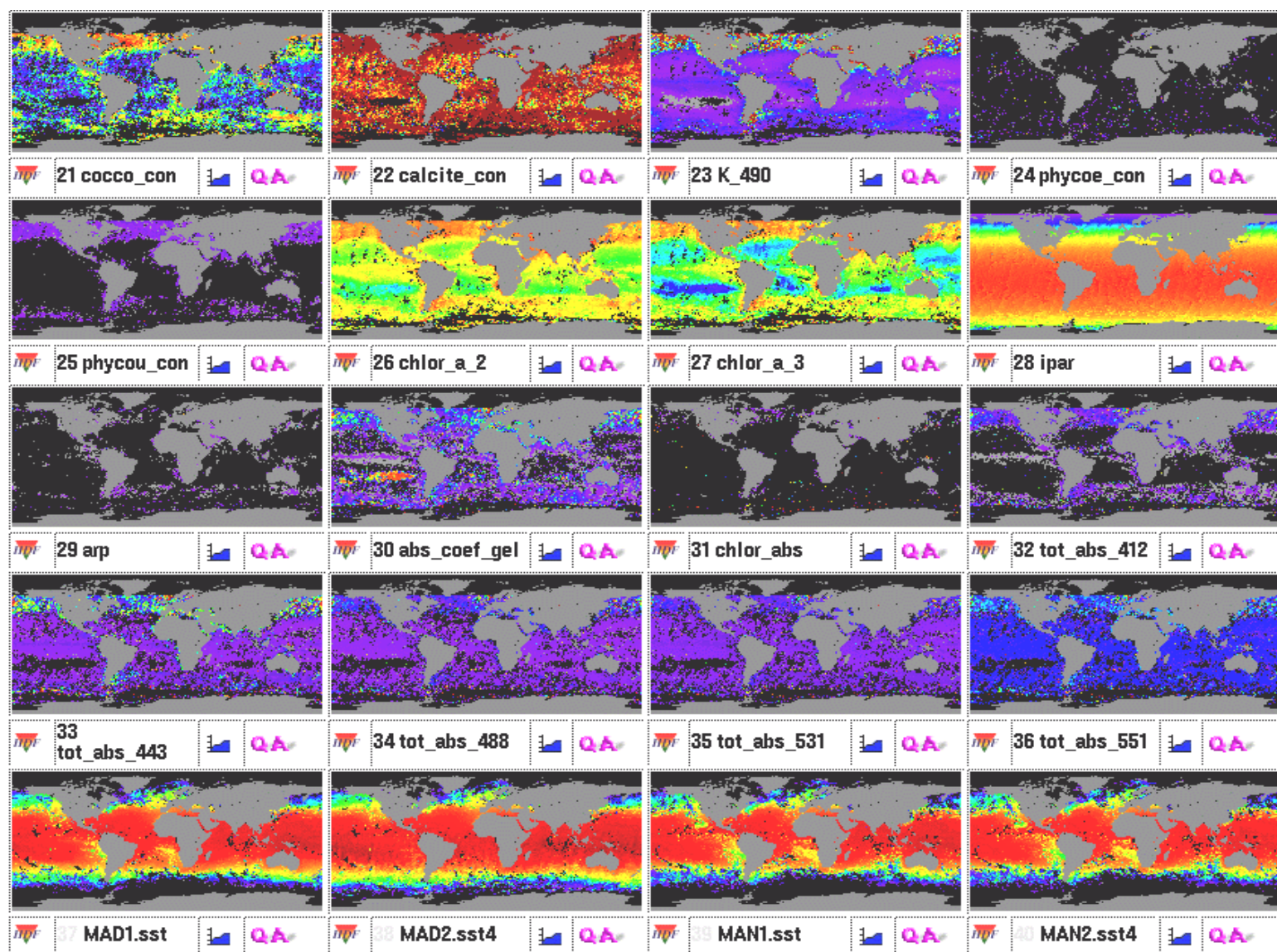
MODIS Ocean

[Home](#) [Data Products](#) [Quality Assurance](#) [Validation](#) [Data Processing](#) [References](#) [Links](#)

Weekly declouded
36Km maps

Week starting Day 313 (November 8, 2000)

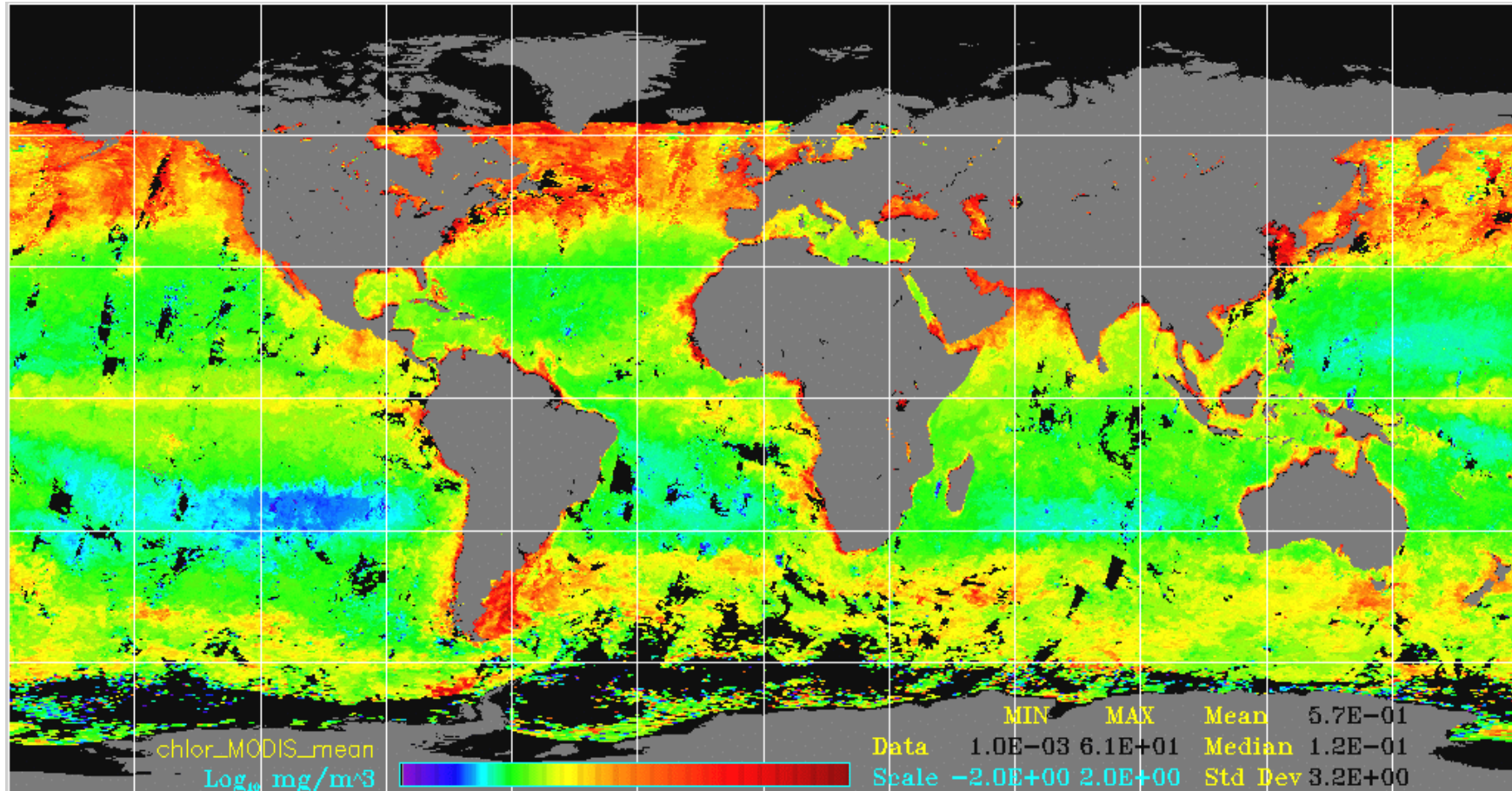





Designed and Developed by: Marius Necsoiu, Futuretech (marius@puffin.gsfc.nasa.gov) and Kevin Turpie, GSC (turpie@ospree.gsfc.nasa.gov)
 Authorized by: Wayne E. Esaias, Code 971, NASA Goddard Space Flight Center

MODIS chlorophyll Weekly, Nov 8 – 15, 2000

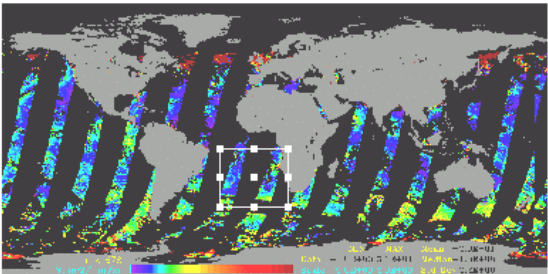
36-km coarse resolution for QA browse



MODIS Ocean QA Database


Cases
New
Sent
Browse

MO36MW02.nLw_443



6.0 S
28.0 W
17.0 E
45.0 S
Zoom In
Zoom Out

Product Analysis
Year/Day:
2000367
Priority:
5
Mean:

Box Comment:
General Comment:

Energize

Current User: Ron_Vogel
Fri Mar 23 22:19:39 EST 2001

[Goddard DAAC S&O](#)
[MODIS OPP](#)
[Miracle](#)
[MODIS Ocean QA](#)
[EOS Data Gateway](#)

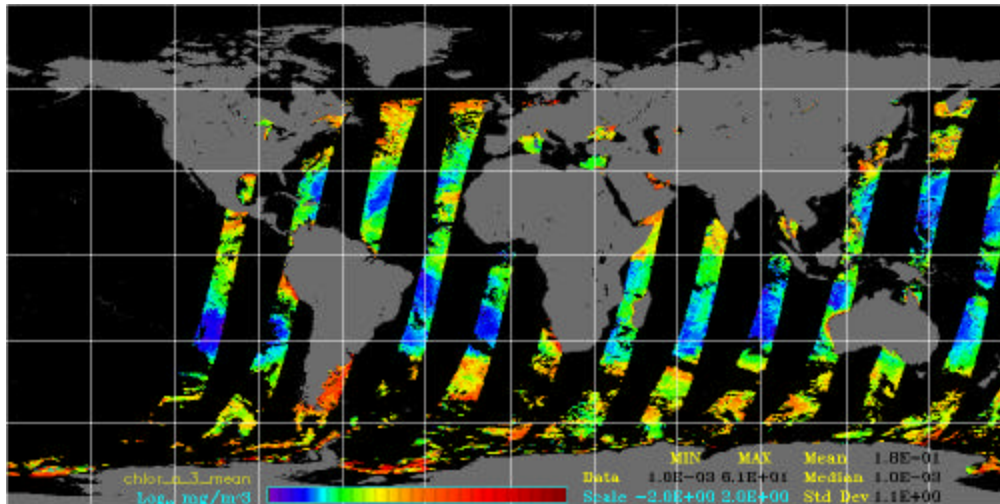
Please note: By clicking on any above links, you will leave the MODIS OCEAN QA database. You will need to log again for further analysis

Java tool for specifying problem geographic regions in coarse-resolution global products.

Regions are sent to MODAT QA DB for Science QA.

Processing QA:

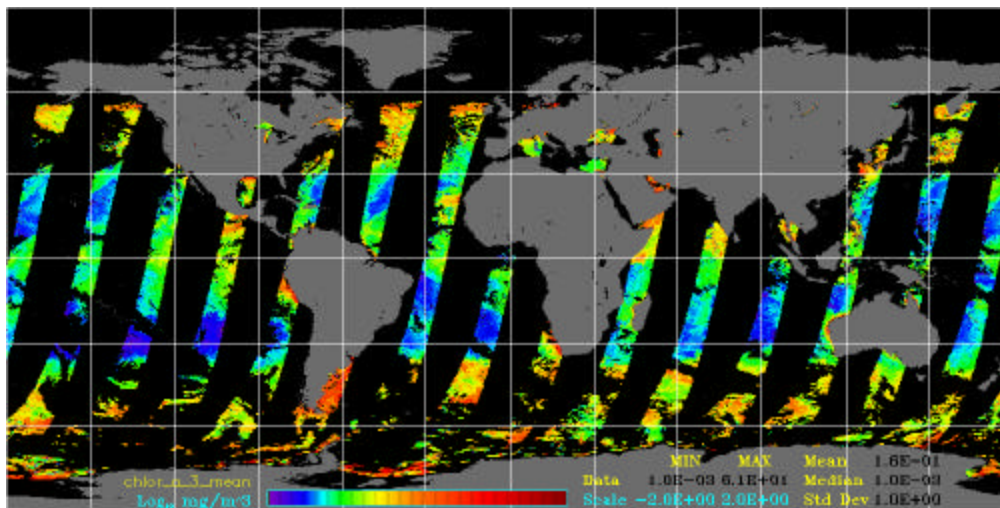
1. Uncovers processing errors so that data can be corrected in a timely fashion



MODIS Chlorophyll, Case 2 Water (3-band)

Daily product 2000.357

Ancillary data missing during creation of Level 2 for hours 20-23; results in missing orbits in daily global Level 3 product.



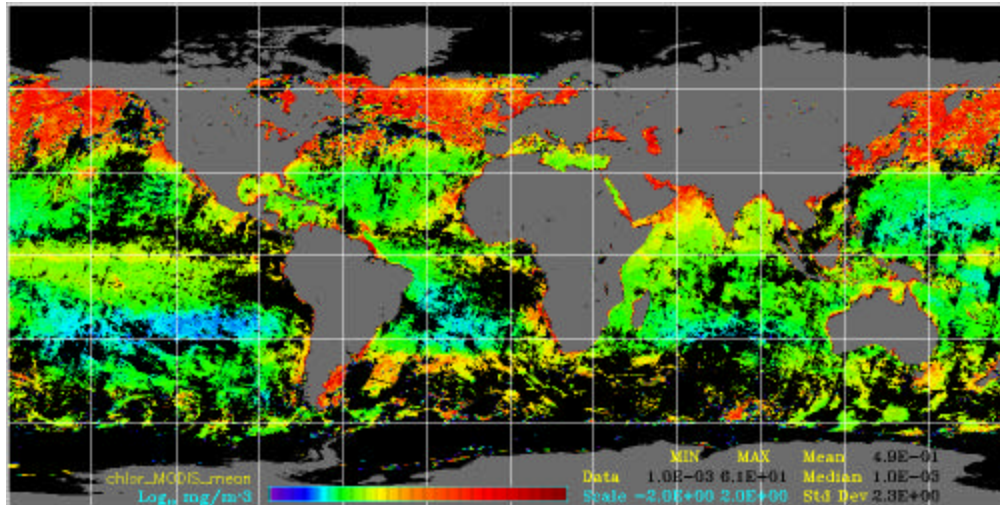
MODIS Chlorophyll, Case 2 Water (3-band)

Daily product 2000.357

Ancillary data restored, Level 2 and Level 3 data regenerated.

Processing QA:

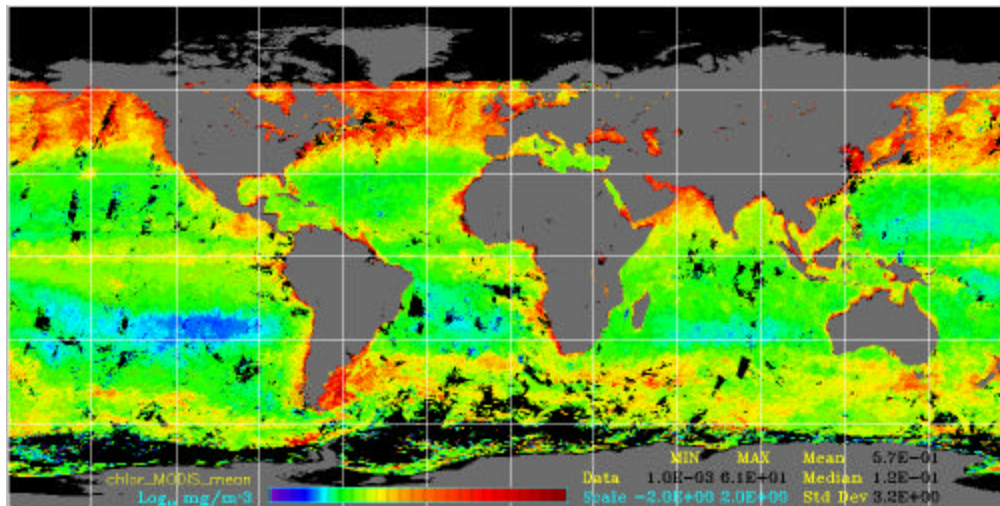
2. Verifies that processing code changes produce the desired results



MODIS chlorophyll

Weekly average 2000.305-312

Improper binning of 36-km products



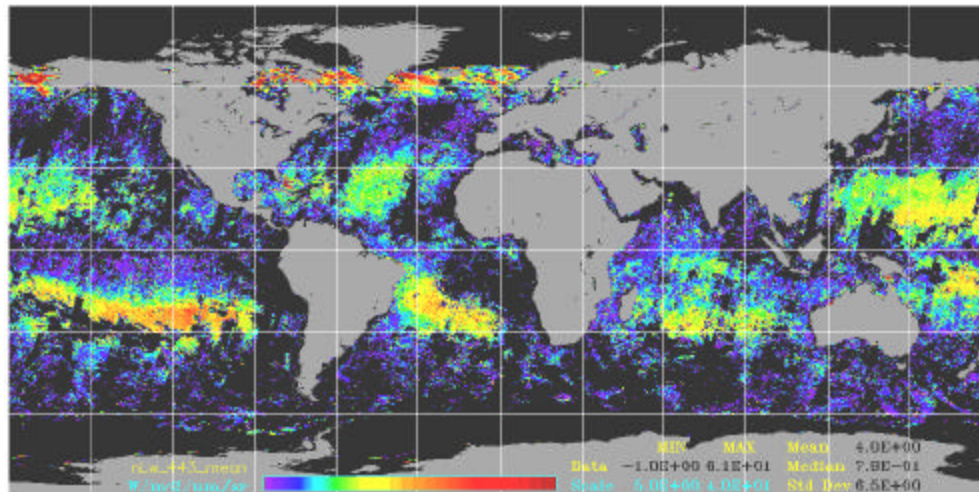
MODIS chlorophyll

Weekly average 2000.313-320

Binning corrected

Processing QA:

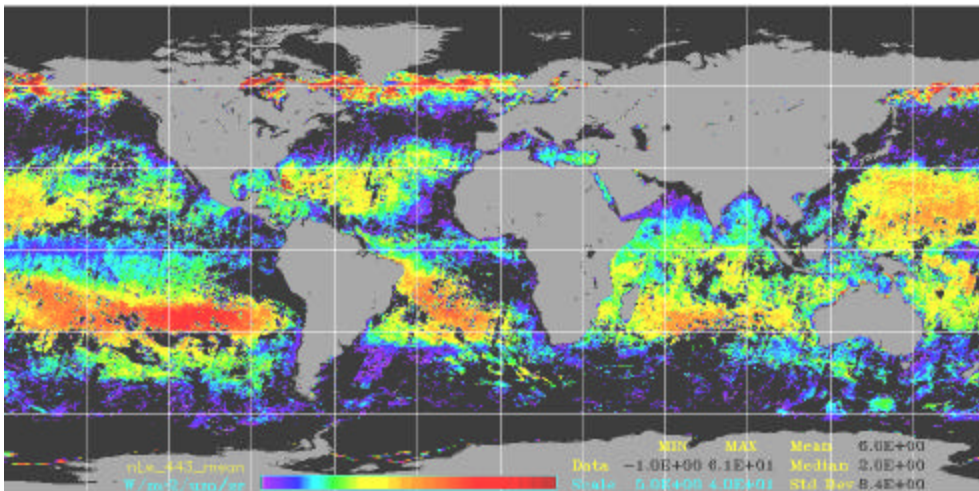
3. Observes effect of sensor changes on MODIS Ocean products



Norm. Water-leaving Radiance at 443 nm

Weekly average 2000.297-304

MODIS A-side electronics
with U.Miami corrections



Norm. Water-leaving Radiance at 443 nm

Weekly average 2000.305-312

MODIS B-side electronics
without corrections

Science QA

- Examines data in both pixel and global contexts to understand differences due to instrumental, code/algorithm, geophysical and biological effects.
 - Sensor characterization
 - Vicarious calibration with *in-situ* measurements
 - Algorithm improvements
 - Refine product QA flags and binning rules
 - Validation match-up database
 - Comparisons to other sensors (SeaWiFS, AVHRR), climatologies. Currently done only on select granules expect to included in Run-time QA during processing in the future.

Science QA Tools

- Parallel processing of selected days and at the Miami SCF
- Miracle web site **<http://miracle.rsmas.miami.edu>**
(visible to MODAT only)
 - Comparison to MODAPS production
 - Analysis of select L1, L2 and L3 granules to understand sensor characterization and calibration
 - Comparisons to other sensors e.g.. SeaWiFS and AVHRR Pathfinder SST
 - Evaluation of QC products and various pixels-level flags
 - Testing of new algorithms and calibrations

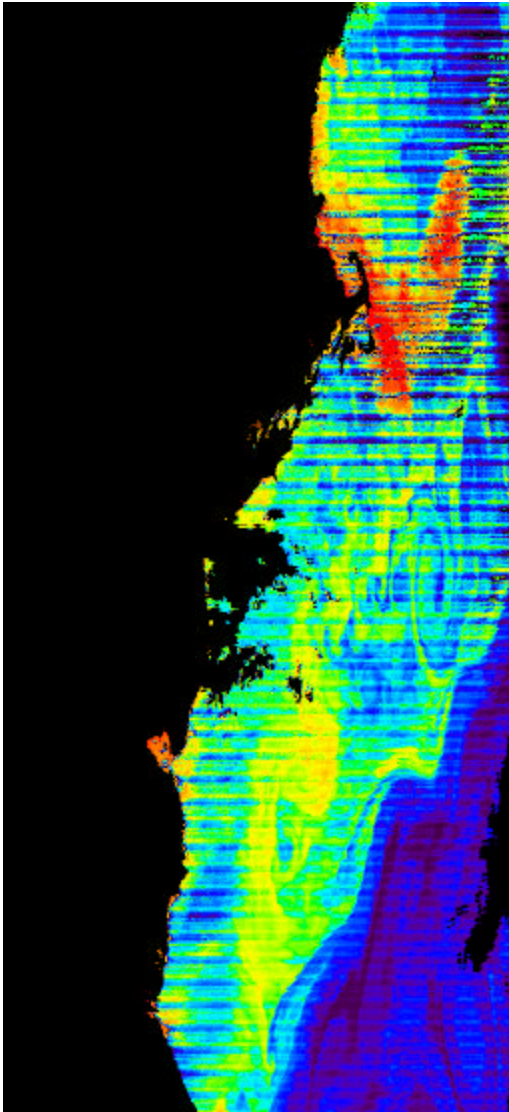
Science QA:

Summary of Known Problems

- **Response versus scan angle (RVS)**
 - A noticeable east-west difference across the scan line is present and is more pronounced at low latitude.
- **Gains are not completely balanced between the two mirror sides resulting in striping.**
- **Angle of incidence (AOI)**
 - Detector response appears to change as a function of mirror AOI
- **Digitizer noise**
 - A-side electronics introduce noise in the sensor A/D conversions, affects $2^{n-1} \rightarrow 2^n$ transitions. B-side electronics have been found to reduce digitizer noise.
- **Channel cross-talk**
 - electrical and optical identified in the L1b product

Summary of Known Problems (cont')

- **Inter-detector discrepancies**
 - The gains on the 10 detectors in a scan are not completely finalized. The imbalance between detectors results in striping and is accentuated by differences in mirror side and at high scan angles.
- **Polarization and sun glint corrections**
 - Current polarization and sun glint corrections are only approximate and will be refined in the future.
- **Absorbing aerosols**
 - The presence of absorbing aerosols are not adequately identified or corrected by the current atmospheric correction. The presence of absorbing aerosols introduces artifacts in both the sea surface temperature and ocean color products, depressing expected radiance values.
- **Sensor Time-dependent Degradation**
 - Corrections are under development and will be implemented in a later reprocessing.



MODIS Case-2 chlorophyll (3-band)

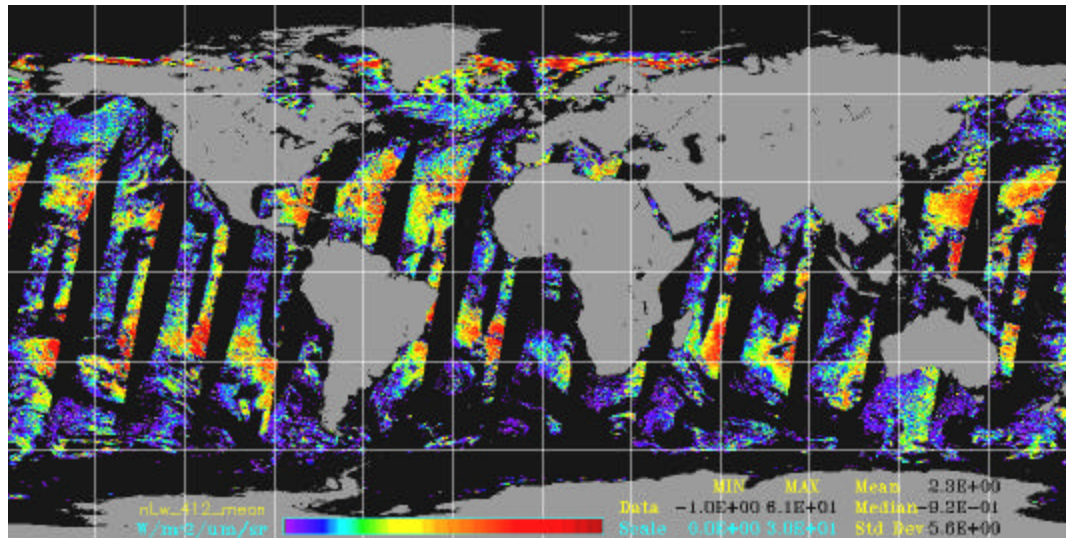
April 7, 2000

U.S. East Coast, Level 2

Depicts striping caused by sensor:

- mirror-side differences
- digitizer noise
- inter-detector discrepancies

Response vs. Scan Angle (RVS) artifact caused by BRDF effect

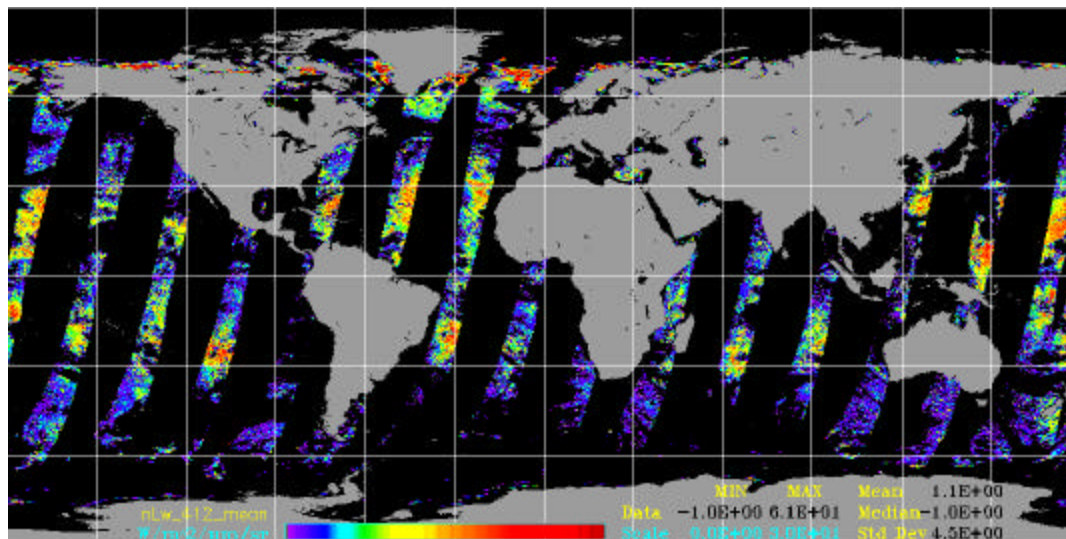


**Norm. Water-leaving Radiance
at 443 nm**

Level 3 Daily

October 7, 2000

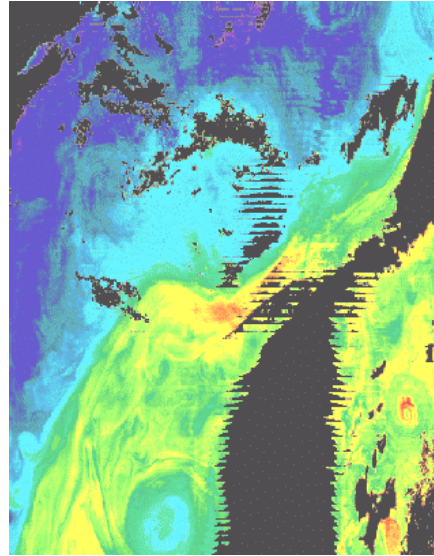
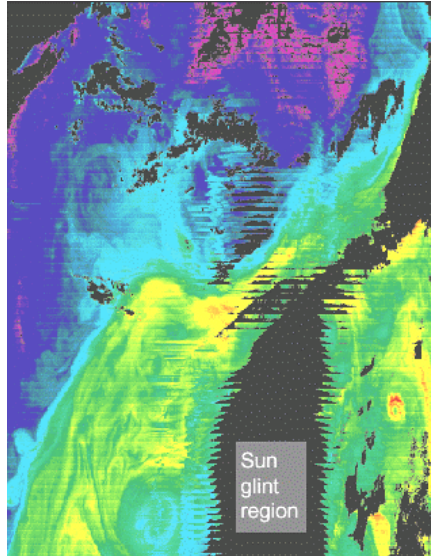
Eastern half of orbit at low
latitudes exhibit abnormally high
values



October 10, 2000

Binning routines remove eastern
half of orbit from daily global
product

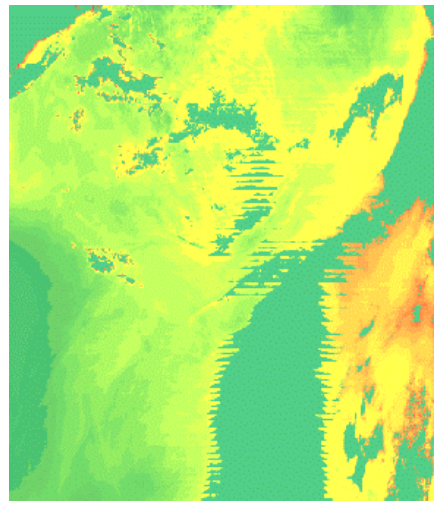
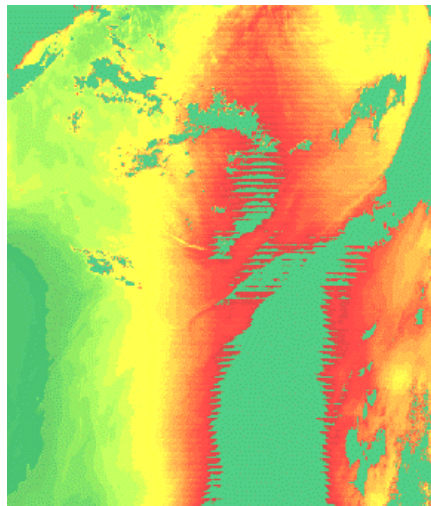
May 8, 2000, Level 2, U.S. East Coast



Destriping Correction

**Norm. Water-leaving Radiance
at 443 nm**

Destriping procedure reveals fine detail
of geophysical features.



Sun Glint Correction

Aerosol radiance at 865 nm

Sun glint contamination removed by
filtering aerosol radiances before
calculation of water-leaving radiance.

Storage of QA results

- Run-time Pixel level information (set during processing stored as an SDS in the HDF file)
 - Common flags
 - Product specific flags
 - Quality levels
- Granule level (QA metadata updates after ingest)
 - Science QA flag
 - flag explanation

Currently we still cannot update the QA metadata at the DAAC and rely on the known problems page to communicate this information to the user

QA database and tracking of QA results

- The QA database is a central component in the process of documenting problems in the MODIS oceans data and updating the associated metadata so that this information can be made available to the scientific community.
- The database provides a repository for QA data on each level 2 granule and global ocean products. Basic QA data consists of flags (pass, fail, and others) and comments at the parameter level. This information is used by associated software to generate metadata update messages which are then processed at the GSFC DAAC .

QA Database Overview

- The system is loaded with L2 and L3 granule metadata from MODAPS and ECS insert metadata publications (containing the ECS UR of the granule).
- Potential problems are identified based on the analysis of globally mapped daily composites (from Processing QA).
- An email message is generated by the 36Km browse QA tool containing the parameter, geographic location and description of the problem and this information is stored in the database.
- Problems are investigated and the database updated with appropriate QA flags and comments.
- An associated program will use this information to generate e-mail messages to update the ECS QA metadata Science QA Flag and Flag Explanation for granules archived at the DAAC when bulk updates become possible in the ECS system.

System Components of QA Database

Associated programs load and query the database to perform basic operations.

Insert/Update Procedures

- L2/L3 Metadata Loader (MLoad) : parses and loads L2 and L3 metadata into the database.
- ECS Metadata Publication Loader (MPLoad) : retrieves parses and loads ECS metadata publications into the database.
- QA Finger (QAFinger) : parses and loads specific email messages containing QA into the database.
- Comment Update (CUpdate) : inserts comments about specific problems from science team members.

QA Database (cont')

Queries

- ECS Metadata Update (METUpdate) : generates ECS metadata update messages based on the QA data collected.
- Interactive Queries : various utilities support browsing the comments and QA flags.
- QAInfo:browse flags and comments on a particular granule.

relates ECS metadata and UR to the granule id.

TABLES

Name	Comment	Column Descriptions	Data Source
Level2	record for each level 2 modis granule	details	Modaps L2 metadata files
MODOCL2	record for each MODOCL2 granule	details	Modaps L2 metadata files
MODOCL2A	record for each MODOCL2A granule	details	Modaps L2 metadata files
MODOCL2BM	record for each MODOCL2B granule	details	Modaps L2 metadata files
MOD28L2	record for each MOD28L2 granule	details	Modaps L2 metadata files
Maps	record for each 36km map / each parameter	details	Modaps L3 metadata files
QABox	record for each QA area flagged for analysis	details	Processing QA email message
QAComments	record for each comment associated with an area from QABox table.	details	Science team member
UniversalRef	record for each insertion of a level 2 or level 3 granule into the DAAC archive.	details	DAAC Metadata publication
Gvalues	record contains data values associated with level2 or level 3 granule	details	???

Current Communication to End Users

- Disclaimer and Known Problems web site
 - General disclaimer and product status
 - Beta, Provisional and Science-quality
 - Listing of known problems under investigation
 - Listing by product of Science QA Flag and Flag Explanation gives dates when QA flags change and period
- MODIS Ocean web pages
 - general product information and sample IDL codes for reading pixel quality levels, common flags, and product specific flags.
 - Trouble ticket web page tracks status of end user reported problems received at the GDAAC



MODIS Ocean Quality Assurance

Known Problems and Artifacts

Last updated: 1/21/2001

Quality and Status of Specific Ocean Parameters

Table 1: Parameter QA Flag and Flag Explanations, 1/8/2001

Parameter Name	Data Date	QA Flag	Quality Flag Explanation
CZCS_pigment	September 15, 2000 (265)	Suspect	Un-calibrated, geophysically reasonable value range
chlor_MODIS	September 15, 2000 (265)	Suspect	Un-calibrated, geophysically reasonable value range
pigment_c1_total	September 15, 2000 (265)	Suspect	Un-calibrated, geophysically reasonable value range
chlor_fluor_ht	September 15, 2000 (265)	Inferred Fail	Un-calibrated, values 10x too high from expected
	October 10, 2000 (284)	Suspect	Un-calibrated, geophysically reasonable value range
chlor_fluor_base	September 15, 2000 (265)	Suspect	Un-calibrated, values in expected range
chlor_fluor_effic	September 15, 2000 (265)	Inferred Fail	Invalid due to failed input product chlor_fluor_ht
	October 10, 2000 (284)	Suspect	Un-calibrated, data range under evaluation
susp_solids_conc	September 15, 2000 (265)	Suspect	Algorithm not functioning, files contain all zeros
	October 10, 2000 (284)	Suspect	Un-calibrated, geophysically reasonable value range
cocco_pigmnt_conc	September 15, 2000 (265)	Suspect	Un-calibrated, when bloom has occurred values reasonable
cocco_conc_detach	September 15, 2000 (265)	Suspect	Un-calibrated, when bloom has occurred values reasonable

MODIS Ocean Quality Assurance

Data Comments Page

Last updated: 1/4/2001

These are problems observed in the MODIS Ocean data that have been reported by data users other than the MODIS Ocean Team. When *reported, problems are directed to the appropriate party for resolution (U. Miami/RSMAS or SDST)*. The status of the problem is tracked here. Other comments useful for *data users are also listed here.*

If you observe a problem or inconsistency in the MODIS Ocean data, metadata, HDF file format, etc., please send your comment to Ron Vogel, ron.vogel@gsfc.nasa.gov

MODIS Ocean Team members should direct their comments about the data to U. Miami/RSMAS directly. Their comments are not recorded here.

Problem #	Reportedby	Description	Status	Resolution	Last update
1	Andrey Savtchenko, GSFC DAAC	Typos in Level 2 HDF metadata attributes: units are incorrect for some parameters (see email 10/16/2000)	Open	Kay Kilpatrick clarified what the correct units should be. See Parameters webpage. Code corrections were submitted by Sue Walsh. All corrected except calcite_conc and raw##: calcite_conc should be mgC/m ³ , raw## should be W/m ² /um/sr	12/29/00
2	Andrey Savtchenko, GSFC DAAC	Typos in Level 2 HDF metadata attributes: MOD28L2 quality SDS (see email 10/17/2000)	Closed	Corrected by Sue Walsh and patched by Bob Woodward into MOD_PR28	10/19/2000
3	Andrey Savtchenko, GSFC DAAC	Parsing error in Level 3 HDF metadata attributes: values of Name and Scaling Equation jumbled (see email 10/26/2000)	Closed	Corrected by Sue Walsh and Bob Woodward	12/13/2000
4	Andrey Savtchenko, GSFC DAAC	Attribute names are inconsistent between Level 2 and Level 3, e.g. name vs Name (see email 10/30/2000)	Open	Will be made consistent in a future delivery by Sue Walsh (see email 10/31/2000)	12/29/00
5	Ron Vogel	MODSQA products and associated maps (MO04MA) were not produced for days 2000.306 - 2000.314.	Closed	These products will not be produced for this time period.	1/4/01
6	Mike Ondrusek, NOAA/NESDIS	Geolocation information in MODOCQC file is 2 decimal places, whereas MOD03 file has 3 decimal places (allows higher precision geolocation)	Open	Miami will investigate scaling in the MODOCQC files, which could be reducing precision	2/13/01

Pageauthor:Ron Vogel, SAIC/GSC

Page authorized by: Dr. Wayne E. Esaias, NASA/GSFC Code 971

Last updated: February 13, 2001

Lessons Learned

- Sensor characterization and calibration has been a much larger problem than anticipated.
- When products were deemed ‘failed’ (unusable), there was no method for marking them as such in the archive. Thus, GDAAC had to spend valuable time deleting thousands of files manually. For example, for the ‘binning error’ that affected 6 weeks of daily and weekly products, 29,886 files had to be manually deleted.
- Need bulk QA metadata updates.

Lessons Learned (cont')

- Not all QA metadata is appropriate for MODIS Ocean. Only one of three metadata QA Flags is expected to be utilized (Science Quality Flag), and only one of four metadata QA Stats is calculated (QA Percent Missing Data).
- Keep QA procedures simple.
 - Reduce complexity of metadata
- Important to have ability to easily change Level 2 product specific calibration and look up tables.
- Need time dependent calibration tables that are easy to swap into operational processing. L2 calibration intimately tied to changes in L1 calibration.

Lessons Learned (cont')

- Keep number of ESDTs at a manageable level. MODIS Ocean has 2915 ESDTs to archive at GDAAC. These are grouped into 126 'multi-type granule ESDTs', but users can't order individual parameters within the multi-type.
- ESDT changes take much longer than science code changes. Need to budget months for any change.

Future Directions

- Automated checks and trending performance
 - Pixel-level QA
 - Metadata QA flag performance
- Checks of data consistency with climatology for major regional shifts in product.
- Examination of ephemeral events which may be affecting performance: red tides, blooms, dust, volcanic eruptions.

More Information

- MODIS Ocean website
<http://modis-ocean.gsfc.nasa.gov>
 - Ocean QA Web Browse
 - <http://modis-ocean.gsfc.nasa.gov/qa/archive>
 - Known Problems, Science QA Flags, Product Status
 - <http://modis-ocean.gsfc.nasa.gov/qa/knownprobs.html>
- Tic Tac Toe charts
 - Data year 2000 (MODAPS V1)
 - <http://mtvs1.nascom.nasa.gov:8001/report/beta>
 - Data year 2001+ (MODAPS V2)
 - <http://moddev.nascom.nasa.gov:8102/reports/status/Configure.md>
- Science QA
<http://miracle.rsmas.miami.edu>
(visible to MODAT only)